Winds of 50 mis./hr. (22.4 m./sec.) or over, during March, 1919.

Station.	Date.	Velocity.	Direction.	Station.	Date.	Velocity.	Direction.	Station.	Date.	Velocity.	Direction.	Station.	Date.	Velocity.	Direction.
		mi./hr.				mi./hr.				mi./hr.				mi./hr.	
Asheville, N. C.	8	50	e.	Evansville, Ind.	17	58	sw.	New York, N. Y.	28	92	nw.	Point Reyes Light, Calif.	8	61	nw.
Block Island, R. I.	28	70	nw.	Fort Smith, Ark.	16	58	sw.	Do.	29	87	nw.	Do.	12	62	se.
Do.	29	60	nw.	Hannibal, Mo.	16	50	sw.	Do.	30	50	nw.	Do.	13	58	sw.
Do.	30	50	nw.	Hatteras, N. C.	26	50	nw.	Norfolk, Va.	27	52	nw.	Do.	14	58	nw.
Buffalo, N. Y.	1	76	sw.	Do.	27	51	nw.	Do.	28	56	nw.	Do.	15	58	nw.
Do.	9	72	sw.	Indianapolis, Ind.	16	54	s.	Do.	29	52	w.	Providence, R. I.	9	52	s.
Do.	10	50	sw.	Lexington, Ky.	17	68	sw.	North Head, Wash.	1	58	s.	Do.	10	59	nw.
Do.	12	52	sw.	Little Rock, Ark.	8	52	w.	Do.	4	52	s.	Do.	28	55	se.
Do.	18	64	s.	Louisville, Ky.	17	56	sw.	Do.	6	56	nw.	Do.	29	52	nw.
Do.	28	50	nw.	Lynchburg, Va.	27	51	n.	Do.	7	50	se.	St. Louis, Mo.	8	50	ne.
Canton, N. Y.	1	51	w.	Memphis, Tenn.	8	54	nw.	Do.	10	60	s.	Sandy Hook, N. J.	1	58	se.
Cheyenne, Wyo.	1	50	w.	Modena, Utah	13	56	s.	Do.	14	52	s.	Do.	9	55	se.
Do.	14	56	w.	Mount Tamalpais, Calif.	5	56	nw.	Do.	15	58	s.	Do.	19	51	n.
Cleveland, Ohio.	18	56	w.	Do.	12	56	se.	Do.	16	54	s.	Do.	28	74	nw.
Columbus, Ohio.	17	52	w.	Do.	13	52	sw.	Do.	17	72	s.	Do.	29	69	nw.
Detroit, Mich.	1	50	sw.	Do.	15	62	nw.	Do.	30	54	s.	Tatoosh Island, Wash.	10	63	s.
Duluth, Minn.	26	50	w.	New York, N. Y.	1	64	s.	Oklahoma, Okla.	15	50	s.	Do.	15	51	w.
Eastport, Me.	9	51	se.	Do.	5	50	nw.	Oswego, N. Y.	28	50	nw.	Do.	17	62	s.
Do.	28	56	e.	Do.	6	50	nw.	Pensacola, Fla.	8	60	s.	Do.	30	52	s.
Ellendale, N. Dak.	14	52	e.	Do.	9	65	w.	Do.	26	52	sw.	Toledo, Ohio.	1	50	sw.
El Paso, Tex.	15	56	nw.	Do.	10	60	nw.	Point Reyes Light, Calif.	3	61	nw.	Trenton, N. J.	28	62	nw.
Erie, Pa.	8	60	se.	Do.	19	51	n.	Do.	5	62	nw.	Do.	29	54	nw.
Do.	9	67	se.	Do.	21	50	n.	Do.	6	80	nw.	Wichita, Kans.	18	88	nw.
Do.	16	52	se.	Do.	22	54	n.	Do.	7	51	nw.	Williston, N. Dak.	14	52	se.
Do.	18	52	sw.	Do.	27	51	se.								

SPECIAL FORECASTS AND WARNINGS, WEATHER AND CROPS.

WEATHER WARNINGS.

By EDWARD H. BOWIE, Supervising Forecaster, Washington District.

At the beginning of the month a LOW was passing down the St. Lawrence Valley and a trough of relatively low pressure covered the Atlantic States. In the southern end of this trough a secondary center developed and moved eastward, attended by rains along the south Atlantic coast. This low pressure system was followed during the 2d and 3d by high barometer and relatively low temperatures east of the Mississippi River. The evening of the 3d, when an extensive system of low pressure was over the West with a storm center over Lake Superior and another over the southwestern Rocky Mountain Region, warnings of strong winds and snow were sent to open ports on Lake Michigan and cold-wave warnings ordered for Upper Michigan. This low pressure system advanced eastward, the northern storm center passing rapidly down the St. Lawrence Valley and disappearing on the 5th, while the southern storm center moved east-northeastward and reached the Atlantic coast on the 6th. General rains were forecast for the Washington District in advance of these LOWS and much colder weather and high barometer advanced eastward in their wakes. Violent local storms occurred on the 5th in the East Gulf and South Atlantic States, attending the eastward passage of the southern storm center just referred to. On the morning of the 4th cold-wave warnings were ordered for Michigan, except the southeast portion, and for northwestern Indiana, and the evening of the same day the display of cold-wave warnings was extended to cover southeastern Michigan, eastern and southern Indiana, Kentucky, east and central Tennessee, Mississippi and Alabama. On the 5th the display of cold-wave warnings was extended to Georgia, North and South Carolina, and northwestern Florida. Much colder weather covered these regions but the fall in temperature was less than that required to justify cold-wave warnings. At 3 p. m. of the 5th when the center of the disturbance was over the upper Ohio Valley, northwest storm-warnings were displayed on the Atlantic coast at and north of Cape Hatteras and during the night of the 5th strong winds, and in some places gales, occurred in the region where warnings were displayed. The next storm of importance to cover the Washington District was central at 8 a. m. of the 8th over eastern Texas, having moved to that region from Nevada in the preceding 48 hours. This storm moved rapidly northeastward and increased greatly in intensity. At 8 a. m. of the 9th, its center (29.40 inches) was at Toledo, Ohio, and at the same hour on the 10th its center (29.18 inches) was near the mouth of the St. Lawrence River. General and heavy rains and gales attended this cyclone during its passage across the Washington Forecast District. On the morning of the 8th storm warnings were displayed on the Gulf coast at and between Bay St. Louis and Tampa and on the Atlantic coast at and between Titusville, Fla., and Cape Henry. At 4 p. m. of the 8th warnings were ordered for the coast north of Cape Henry to Boston and at 10 p. m. of the same day the region of storm warning display was extended northward to Eastport.

Warnings of northeast gales and snow were sent open ports on Lake Michigan. Gales occurred as forecast and there were heavy snows in parts of lower Michigan. The air pressure increased and remained above normal after the eastward passage of this storm until the 15th. Warnings of the coming of high winds were dispatched to open ports on Lake Michigan on the 12th and 13th and on the latter date northeast storm warnings were displayed on the Atlantic coast at and between Sandy Hook and Eastport. On the morning of the 13th cold-wave warnings were ordered for New England and considerably colder weather followed during the succeeding 24 hours. On the 15th the pressure had become subnormal generally west of the Mississippi River, with storm centers over North Dakota and New Mexico and rains had already set in over the great central valleys. This low pressure system advanced slowly eastward and rains continued over much of the country east of the Mississippi River until the 19th. On the 16th and 17th heavy and general rains and local wind storms occurred in the Ohio and lower Mississippi Valley and the East Gulf States. These conditions had been previously forecast. Warnings of strong winds were sent to open ports on Lake Michigan on the 16th and 17th, and on the 17th at 3 p. m. storm-

warnings were displayed on the Atlantic coast at and between Boston and Cape Henry, and at 6 p. m. of the same day warnings were ordered for the Atlantic coast north of Boston. Strong winds occurred during the following 24 to 36 hours in the region where warnings were displayed. This low pressure system was followed by high barometer and cool weather generally west of the Mississippi River during the 19th to 25th, during which period frequent forecasts of frosts were necessary for the Middle Atlantic and interior of the South Atlantic and East Gulf States; also on the 19th northeast storm warnings were necessary on the Atlantic coast between Boston and Sandy Hook, because of the presence of a storm of considerable intensity near the Bermudas.

The pressure remained low over that region until the 24th, when the storm center passed northeastward to the Grand Banks. Strong winds prevailed off the north Atlantic and middle Atlantic coasts from the 19th to 24th. During the 25th the barometer was low over the Great Plains and the southern Rocky Mountain region and on the 26th this low pressure system was over the Mississippi Valley in the form of a "trough" that extended from Louisiana northward to Lake Superior. This "trough" advanced eastward and on the 27th it covered the interior of the Atlantic States and general rains were then falling over the eastern States. There were strong indications at this time (8 a. m. of the 27th) that the southern end of this trough would become an intense storm in the succeeding 24-hours and, in anticipation of this formation, storm warnings were displayed on the Atlantic coast at and between Jacksonville and Nantucket and on the afternoon of the same day the region of display of storm warnings was extended northward to Eastport. By 8 p. m. of the 27th the center (29.44 inches) of the storm was over New Jersey and at 8 a. m. of the 28th it was near Block Island, R. I., where the barometer stood at 29.14 inches. After remaining approximately stationary for twelve hours the center of the disturbance passed eastward off the coast. Severe gales prevailed along and off the New England and middle Atlantic coasts from the night of the 26th until the end of the month, and heavy snow fell in parts of New England and New York. The warnings of the severe gales were issued well in advance of their occurrence and were no doubt effective in preventing loss of life and of ships. This storm was followed by decidedly colder weather, the display of cold-wave warnings being necessary on the 26th for upper Michigan, on the 27th for the interior of New York and northern New England and on the 28th for parts of southern New England. Moreover, frequent warnings of frosts were necessary for the southern States on and after the 27th of the month.

WARNINGS FROM OTHER DISTRICTS.

Chicago, Ill., forecast district.—Cold-wave warnings were issued for the entire district, except Montana and North Dakota, on the 3d–4th. They were fully verified in northern sections and partially to the southward, but failed of verification in Wyoming, because of the advance of an area of high pressure eastward from the middle Pacific coast.

The only other warnings of importance were those issued for the Dakotas, Minnesota, southern Montana, and extreme northern Wyoming on the 19th. These were mostly verified, except in extreme northern Wyoming.—*Chas. L. Mitchell.*

New Orleans, La., forecast district.—Northwest-storm warnings were issued on indications of the evening map of March 4 and were verified by moderate northwest gales, which attended a moderate HIGH as it moved southward in the rear of a trough of low pressure extending in a northeast-southwest direction.

Small-craft warnings were displayed from Galveston to New Orleans during the afternoon of the 8th, and on the Texas coast during the 25th, and were justified.

On the morning of the 3d a trough of low pressure, with centers over eastern South Dakota and northern Colorado, was advancing southeastward, followed by moderately high pressure from western Canada, with a pronounced temperature gradient. Freezing weather within 36 hours was forecast for the northwestern portion of the district and cold-wave warnings were issued at night for Oklahoma and northwestern Arkansas. The cold-wave warnings were extended on the morning of the 4th to include northern Louisiana and the northern and western portions of east Texas and were further extended in the afternoon over the southeastern portion of east Texas except the extreme west of the coast. Cold-wave warnings were issued on the morning of the 5th for eastern and southern Louisiana. The warnings were verified except in coast sections, where cloudiness generally prevailed on the morning of the 5th and the temperature fall was less than over the interior. Stockmen were given timely notice of the cold wave also.

A cold-wave warning for Oklahoma and the Texas Panhandle issued on the 19th, proved to be not justified. While the area of high pressure in this instance pushed southward along the eastern slope of the Rocky Mountains with a large increase of pressure, the position and movement of the area of low pressure were unfavorable and the temperatures were not unusually low.

Frost warnings were desired only in coast sections at the beginning of the month but were requested for all sections, except the extreme northwest, by the 31st. Warnings of frost, or freezing temperature, or lower, were issued for some portions of the interior on the 5th, 8th, 10th, 11th, 12th, 13th, 17th, 21st, 25th, 26th, 27th, 28th, and 30th, and were verified in most instances.

Fire-weather warnings were issued for the forested regions of Oklahoma on the 13th and 14th, and of Arkansas on the 14th, and were justified.—*R. A. Dyke.*

Denver, Colo., forecast district.—Unsettled weather predominated in the Denver forecast district during March, but temperatures were not severe; in fact, considering the large number of deep low-pressure areas that crossed the central and southern parts of the district, the interruptions to the prevailing mild weather were slight and of short duration. This was unusually true of the northern quadrants of the depressions. In the southern part of the district, especially in New Mexico, there was a remarkable persistency of precipitation during the last decade, with heavy rains and snows on the eastern slope.

On the morning of the 3d a low-pressure area was central in southeastern Colorado while high pressure with zero temperatures prevailed in eastern Montana and Alberta. Cold-wave warnings were issued in the morning for northeastern Colorado, and warnings of a moderate cold wave in the evening for southeastern Colorado. Sharp falls in temperature occurred, but technically the warning was verified only in the eastern border counties. On the morning of the 19th, warnings for the lambing and sheep shearing interests of Utah were issued in anticipation of the coming of colder weather with rain or snow. There was a general fall in temperature, but the precipitation was local. In the evening, warnings of a moderate cold wave in eastern Colorado were issued. Temperature falls of 28° to 32° occurred throughout the eastern half

of the State. On the morning of the 25th low pressure overlay the southern Rocky Mountain region with one of the low centers in southeastern Colorado, while the crest of the anticyclone north of Montana was fully six-tenths of an inch higher. The warning issued was for a moderate cold wave in extreme eastern Colorado. The front of the high-pressure area moved southeastward and sharp falls in temperature occurred, but it is doubtful whether the warning was justified over a considerable area. A frost warning was issued for southeastern New Mexico on the morning of the 26th; this warning was fully verified, several of the substations in the Roswell fruit district reporting a reading of 32°.—*Fredk. H. Brandenburg.*

San Francisco, Cal., forecast district.—During the first and second decades stormy weather continued with but little cessation in the north Pacific States and occurred with marked frequency in northern California and the Plateau region. There was another stormy period in the coast States, from central California north, near the close of the month. In southern California there were two rainy spells; from the 13th to 15th, and from the 19th to 22d. While there were a large number of rainy days in this district, except in southern California, the precipitation for the month was below normal except near the coast from Eureka to Roseburg and at Tatoosh Island.

Storm warnings were ordered on nine days and small-craft warnings on two. Live-stock warnings were issued on the 14th and 15th and on the 19th, for the northern Plateau region and northeastern California. These were only partially verified, as the conditions did not develop the severity expected.

The storm of the 13th and 14th gave the highest winds of the month in California, with hail and thunderstorms at many places in the interior, snow on the mountains around San Francisco Bay and extending well down in the foothills of the Coast Range and Sierra Nevada Mountains. On the 13th, lightning struck the residence of Mrs. Manuel Paulo, in the southwestern portion of Stockton, San Joaquin County, tearing a hole nearly 2 feet in diameter through the roof. Mrs. Paulo, her baby, and a neighbor were in the house at the time but none of them was injured. During the same storm, in Los Angeles County, a small church collapsed at Otterbein and the roof was blown from a farmhouse and power lines were badly damaged in that vicinity.

The temperature was above normal in the northern portion of this district and below in the southern. There were no marked cold spells. Heavy frosts occurred on several mornings in California, but they were not severe enough to cause injury.

At the close of the month deciduous fruit was in full bloom in California and no injury had been reported from either frost, rain, or winds.—*G. H. Willson.*

RIVERS AND FLOODS, MARCH, 1919.

By H. W. Smith, Temporarily in Charge.

[Dated: Weather Bureau, Washington, Apr. 30, 1919.]

The melting of snow and breaking up of the ice in the Connecticut River on the 21st to 23d caused some ice gorges and the river was about bank-full. Heavy rains on the 26th and 27th caused a second rise to moderate flood stages. But little damage was done.

Moderate to heavy rains in the south Atlantic States from the 7th to 9th caused most of the rivers to rise from 1 to 5 feet above flood stages. Losses were confined mostly to bridges and live stock.

The floods that were in progress in the east Gulf States at the end of February had subsided by the end of the first week of March. Rains were generally heavy from the 5th to 9th, causing most of the rivers to pass flood stages. The greatest rise was in the Alabama River, which was 14 feet above the flood stage at Selma, Ala. A second rise occurred in the Tombigbee and Pearl Rivers from the 19th to 21st. Only the very lowest river bottoms below Tuscaloosa, Ala., were overflowed. The West Pearl River was above flood stage during the entire month.

General rains and melting snow on the 15th and 16th caused moderate flood stages in northwestern Ohio and in southern Michigan. Losses were largely confined to roads, buildings, and suspension of business.

General moderate to heavy rains on the 5th and 6th, 8th and 9th, and 14th to 16th over the Ohio River watershed caused most of the streams to rise slightly above flood stages. The Ohio River was in flood from Henderson, Ky., to the mouth of the river and the Tennessee River passed the flood stages at most places below Guntersville, Ala. As but little plowing had been done and no planting, the losses were confined largely to harvested crops and live stock.

The Miami and Stillwater Rivers were slightly above flood stages on the 17th and 18th, causing a suspension of construction work of the Miami conservancy district. But little damage was done, except that due to suspension of work.

Very heavy rains occurred in Chester and Decatur Counties, Tenn. The following account was furnished by Roscoe Nunn, meteorologist, Nashville, Tenn.:

There was an unusually heavy rainfall over the western part of Tennessee on March 16 and the early morning of the 17th (see figure). The largest amounts recorded were 10.80 inches at Perryville, Decatur County, and 10.58 inches at Henderson, Chester County. Nearly all stations located west of a line extending from Robertson to Hardin

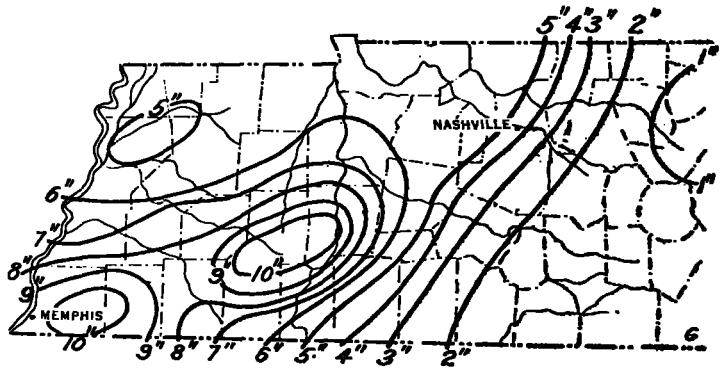

FIG. 1.—Heavy rainfall in West Tennessee on Mar. 16-17, 1919.

Counties received a total of 5 inches or more, while to the east of this line the rainfall was much less. At Memphis 9.72 inches were recorded in 24 hours, exceeding all previous 24-hour records. Of this amount 8.72 inches fell in 12 hours, from 10 a. m. to 10 p. m. of the 16th.